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Fish kills have occurred in the reservoir below the U. S. Bureau of Reclamation's Grand Coulee Dam due to total dissolved gas supersaturation (TDGS). The most severe mortalities have occurred after spilling water via the outlet tubes at Grand Coulee Dam, though water with TDGS typically occurs above the dam as well. Exposure to water with TDGS can cause gas bubble disease (GBD) in aquatic organisms. This disease, analogous to "the bends" of human divers, can range from mild to fatal depending on level of supersaturation, species, life cycle stage, condition of the fish, and temperature of the water.

The current Clean Water Act standard is 110 percent of saturation. Total dissolved gas supersaturation below Grand Coulee Dam can reach levels fatal to fish (>130 percent), and mortalities to resident fish in the reservoir and farmed fish held in netpens have been documented (Elston, 1998). What is not known is whether the episodes of high TDGS are causing significant mortalities in the resident fish populations, or if the fish in netpens are more or less susceptible to GBD than resident fish. Because hydrostatic pressure compensates for increased TDGS (1 m of depth compensates for about 10 percent TDGS), fish can avoid the adverse effects of TDGS by swimming to deep water.

It is still unclear whether fish actively avoid water with TDGS or if observed depth compensation is due to the natural depth preferences of fish. Laboratory and field studies have produced mixed results as to whether fish alter their behavior in response to TDGS levels.

- Determine the species composition and distribution in the lake so that we can determine where and when to collect fish.
- Determine the prevalence and severity of GBD in fish collected.
- Determine if fish are protected from the adverse effects of GBD by depth compensation.
- Determine the significance of observed signs of GBD on selected species.

Dam operations at Grand Coulee in 1999 produced relatively low TDGS levels, and therefore, little evidence of GBD was evident in resident fishes. Over 5,000 fish of 20 different species were examined for GBD signs in 1999, and only a single fish was found to be symptomatic. The significance of GBD in resident fishes was, therefore, minimal in 1999. However, different dam operations or environmental conditions could produce significantly different results. Gas bubble disease data collected in 1999 will provide valuable baseline information against which future GBD data can be compared when conditions more closely resemble 1997, when TDGS was greater than 120 percent for most of the period between mid-April and July.

Two relatively distinct fish communities exist in the reservoir below Grand Coulee Dam. The upper one-third of the reservoir is dominated by a rainbow trout, largescale sucker, and bridgelip sucker community, while the community in the lower one-third of the reservoir is composed primarily of northern pikeminnow (formerly

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northern squawfish) and redbreasted shiners. The middle one-third of the reservoir acts as a transition zone between these two communities. Finally, walleye, sculpin, and longnose suckers are present in both communities, and are found throughout the reservoir.

Acoustic telemetry using depth sensitive transmitters showed most fishes spend most of their time at depths between 1 m and 6 m. Residence at these levels would provide hydrostatic compensation for the TDGS levels observed in 1999. However, during periods of high TDGS levels (e.g., 1997) this may not provide sufficient protection from GBD. This would be particularly true for certain species, like rainbow trout, which were found to be more surface oriented than other fish in this study.

USGS-Biological Resources Division

Literature Cited:

Elston, R. 1998. Fish kills in resident and captive fish caused by spill at Grand Coulee Dam in 1997. Report by Aquatechnics to the Confederated Tribes of the Colville Reservation, Nespelem, Washington, and Columbia River Fish Farms, Omak, Washington.